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ABSTRACT

This report describes the movement characteristics of a three year old boy and girl as they performed a one-handed striking task over a one year period. Observations were made at 4 month intervals as part of a filmed, longitudinal study on the development of motor patterns. The one-handed striking pattern was elicited by asking the children to hit a suspended ball as hard as possible toward a wall. Over a year's time the girl's pattern changed from a) no weight shift to a shift of weight with a step toward the ball, and b) from initiation of the motion with horizontal adduction of the striking arm to initiation of the motion using simultaneous pelvic and spinal rotation. Two major changes observed in the boys pattern were a) progressively longer stride toward the ball and b) a progressively greater pelvic and spinal rotation. (Additional movement characteristics are observed and noted.) (Author/JB)

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CASE STUDIES IN THE DEVELOPMENT OF ONE-HANDED STRIKING*

A report to the Research Section at the National Convention of the American Association for Health, Physical Education and Recreation, Minneapolis, April, 1973

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The purpose of this report is to describe the movement characteristics of a young girl and boy as they performed a one-handed striking task over a one-year period. Observations were made as part of a filmed longitudinal study on "Ontogenetic Development in Selected Motor Tasks," which began in 1962 under the direction of Lolas E. Halverson, Motor Development and Child Study Center, University of Wisconsin-Madison. The cinematographic data on the girl analyzed for this presentation were collected between January, 1966, and January, 1967; they consist of nine trials selected from four consecutive film sessions beginning when she was 3 years, 4 months old. The data on the boy were obtained between May, 1963 and May, 1964, and consist of four trials collected from three consecutive film sessions beginning when he was 3 years, 7 months old.

The one-handed striking was elicited by asking the children to hit a suspended ball as hard as possible toward a wall. Since securing verbal and quantitative data from film to describe ontogenetic change in movement remains a tedious procedure, not more than two trials from each data collection session were selected for analysis. Within the limits of film quality and clarity, these trials were judged to be the child's best efforts during that session toward attainment of skilled one-handed striking as described by Roberton (1963), Gelner (1965), and Wickstrom (1970).

The selected film trials were viewed and studied repeatedly using a Lafayette Analyzer Projector, which could slow or completely stop the action. A more accessible record, which also permitted the study of several frames of 16mm film simultaneously, was obtained by tracing the image projected by a film reader or by photographing selected frames with a Testrite Cinelarger.

Since by his preference the boy's earliest striking activities consisted primarily of hitting self-tossed or aerial balls, few suspended-ball trials were available. This report, therefore, will stress the observations of the girl's striking pattern, with comparisons to the boy's data where appropriate.

The earliest response by the girl, M.R., at 3 years 4 months was clearly "arm-dominated" (film). That is, horizontal adduction of the striking arm was the principal joint action. There appeared to be neither a shift of weight nor spinal or pelvic rotation. The racket traveled through a range of approximately 90° before contact. The entire action, from initiation of the short backswing to contact, was accomplished in approximately 225 milliseconds.

In contrast, her response at the next filming session was one of total body involvement (film). In addition to the horizontal adduction of the striking arm observed three months earlier, her movement was characterized

by a step and shift of weight toward the ball; forward inclination of the trunk; hip and knee flexion; and simultaneous spinal and pelvic rotation. The sequence began with the step toward the ball on the contralateral leg as the racket was carried through the backswing, followed by the simultaneous spinal-pelvic rotation toward the ball. Halverson and Roberton (1966) have also reported this "block" rotation in the early development of one-handed striking in another female subject in this same longitudinal study, but observed that it appeared to be a result of the arm swing rather than an initiating action. Such was not the case here. In seven of the eight trials characterized by block rotation, such rotation appeared to occur simultaneously with forward motion of the racket. In one of the trials filmed when M.R. was 3 years 7 months old, it was observed that block rotation preceded the initiation of forward motion of the racket by 75 msec. and, in fact, began as the racket was still moving away from the ball. In all four of the boy's trials studied, block rotation and racket motion toward the ball were initiated simultaneously.

Of the six trials in which M.R. initiated her movement with a step on the contralateral foot, five were characterized by an identical ordering of events: placement of the contralateral foot was followed by the simultaneous initiation of block rotation and forward motion of the racket as the body weight appeared to be moving toward the center of the base of support. This sequence was also observed in two out of the three trials in which H.R. initiated his striking action with a step on the contralateral foot. The exception for each child was a trial in which rotation appeared to occur after the body weight had reached the center of the base of support and was moving toward the contralateral side. Generally, when the initiation of block rotation followed the touch-down of the contralateral foot in rapid succession, the body weight reached the contralateral side prior to, or shortly after contact. In all four of H.R.'s trials, the body weight reached the contralateral side before contact: the time interval between touch-down of the contralateral foot and forward rotation ranged from 30-75 msec. In the four performances of M.R. characterized by completion of the weight shift close to contact, the range was greater: 71-169 msec. In M.R.'s remaining trials the temporal relationships were quite variable: the initiation of the weight shift, defined as the time at which the contralateral foot touched down, varied from 750 msec. before contact to 56 msec. after contact, and the duration of the weight shift

ranged from 85-915 msec. Thus, H.R. not only initiated his weight shift later (i.e., closed to contact), but he was also able to move his weight to the contralateral side much faster than M.R.

An interesting phenomenon related to stepping toward the ball is that of "opening up," which can be simply defined as the simultaneous movement of separate or distinct body parts in opposite directions. In a striking task, for example, movement of one body part in the direction of force production while another part moves away from that direction reflects the child's ability to isolate and differentiate body parts. Observations of children as they perform other motor tasks have suggested that many are not able to do this during early developmental levels. Wild's (1938) throwing Stage II, for instance, was characterized by rotation of the whole body right, and left above the stationary feet. As the arm initiated the throwing action, the entire trunk went forward with it. This lack of "opening up" is also characteristic of the flexion-extension movements in Wild's Stage I.

Our observations have suggested that "opening up" in the one-handed striking task is coincident with the appearance of an initiating step toward the ball. Whenever such a step was observed, movement of the racket away from the ball occurred at the same time. It may be recalled that in one trial, filmed when M.R. was 3 years 7 months old, she not only moved the racket away from the ball as she stepped toward it, but was able to continue to do so for 75 msec. after block rotation had started toward the ball! Hopefully, continued observation will give us additional insight into the phenomenon of "opening up" in one-handed striking, as well as in other motor tasks. We suspect, for example, that it is quite prominent in the whip-like action of skilled overarm throwing.

This sequence (slide #1), H.R.'s earliest response, not only illustrates the phenomenon of "opening up," but also reveals that he was already able to make an adjustment to the ball by taking more than one step. The first was a small step toward the ball on the right foot, and the second was a long stride diagonally forward on the contralateral foot. Note the simultaneous movement of the racket away from the direction in which the two steps were taken.

H.R.'s adjustment at 3 years 7 months can be compared with M.R.'s only attempt in the nine trails to readjust her position; this occurred when she was 4 years 2 months old (slide #2). In order to "square" her body with the intended line of flight, she began stepping out with, and medially rotating

her right leg. In so doing, she placed her body ahead of the ball so that contact was made before the striking arm reached the midline of the body. Unlike H.R., who completed his shift of weight before contact regardless of ball position, she was unable to bring her weight through to the contralateral side until 196 msec. after contact. Note that her left foot is completely unweighted at contact.

The grip used by each child appeared to be within what Napier (1956) has identified as the "power grip complex." H.R. placed his hand well behind the racket in a club-like grip, which often forced his striking arm into flexion at the elbow with an open racket face at contact. M.R.'s grip, although still slightly behind the racket, was closer to the classic Eastern grip; separation of the index finger from the other three was usually evident.

Both children exhibited wrist hyperextension and shoulder retraction during the backswing, followed by rapid wrist flexion prior to contact. H.R.'s wrist, however, often remained slightly hyperextended at contact. Both children also consistently closed their eyes at or near contact, but were able to maintain a stable head position, successfully isolating the movement of the head from that of the shoulder girdle.

In summary, over a one-year period beginning when she was 3 years 4 months old, M.R.'s striking pattern progressed from one in which there was no weight shift and the forward motion of the racket was initiated with horizontal adduction of the striking arm (slide #3), to one which began with an increasingly larger step and shift of weight toward the ball, with initiation of the forward motion of the racket by simultaneous spinal-pelvic rotation (slide #4). In contrast to the obvious changes in M.R.'s one-handed striking pattern, variations within H.R.'s four trials over the one-year period were quite subtle. All of his attempts were initiated by a step forward the ball followed by forward motion of the racket through simultaneous spinal-pelvic rotation*, with a shift of weight to the contralateral side before contact (Slide #1). Variation was observed in the length of the stride* and the range through which the racket traveled before contact.

*Thorough re-examination of the data did not support the earlier conclusion printed in the abstract.

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